Global Journal of Environmental Science and Technology: ISSN-2360-7955, Vol. 9(6): pp: 018-026, June, 2021.

Full Length Paper

Evaluation on the Production of Fuels in a Fractional Distillation Tower: A Case-Study of WRPC

[*1]Akusu O.M., [1]Usman, B.M., [1]Udumebraye J.E.

[1-3]Department of Mechanical Engineering, Petroleum Training Institute, Effurun, Delta State, Nigeria.
Email: akusu_om@pti.edu.ng, usman_bm@pti.edu.ng, josephjobraye@gmail.com

Abstract

Crude oil is a fossil fuel, formed millions of years ago naturally from decaying plants and animals living in ancient seas, hence, places where Crude oil are found were once sea beds. The study involves the evaluation on the production of fuels in a fractional distillation tower in order to analyze the distillation tower or column the processes involved in the production of fuels will be taken to consideration and also production rate of each of these fuels are taken with the total and partial productivity calculated to known when the company's peak production occurs, using six (6) months survey to get our result. For the six (6) months survey result in United States Dollar (USD) from March to August, the total productivity for the six (6) months are 15103USD, 18483USD, 19497USD, 21003USD, and $19903USD respectively.

Keywords: Fossil Fuel, Fractional Distillation, Productivity

1. BACKGROUND

Crude oil is a non-renewable natural and finite resource found in rocks. When pumped out from the ground, it comes in form of a complex mixture of a very large number of compounds most of which are hydrocarbons, molecules composed of hydrogen and carbon atoms only and many of them are hydrocarbons called alkanes (a particular series of organic compounds), crude oil cannot be used directly but must be refined before commercially useful products are produced by the petrochemical industry called oil refinery. Also, the crude oil contained water which is separated from it using industrial separators. The hydrocarbons comprises of molecules based on chains of carbon atoms (mostly 1 to 40) sometimes linear (straight) and sometimes branches (a side – chain of c atoms) and other are based on rings of carbon atoms. Crude oil cannot be used directly but must be refined before commercially useful products are produced by the petrochemical industry called oil refinery. The complex mixture of hydrocarbons include oil can be separated into fractions by the technique of fractional distillation. It is then processed and refined and into varieties of form such as premium motor spirit (PMS) i.e petrol, dual purpose kerosene (DPK). i.e kerosene, automotive gas and oil (AGO) i.e diesel and liquefied petroleum gas i.e kerosene, automotive gas and oil (AGO) i.e diesel and liquefied petroleum gas which are also referred to as simply propane or butane. Other crude oil productions are grease, lubricating oil and bitumen.

Some of the problems with the production of fuels without using a fractional distillation tower could be related to large carbon and hydrogen. Through these processes with lots of chemical reactions with oxygen in the air leads to greenhouse effect. They do not absorb the visible radiation coming from the sun, so the earth gets its full share of that. The major aim and objective of the study is to determine the quality and verities of fuels that are obtain from tank of crude oil and to know the production and productivity of fuels. The objectives of this project are: To know the types of fuels produced from crude oil; to know the densities and temperatures at which each fuel is produced and to know the maximum production period of the fractional distillation tower when it is in operation. The scope of the study is to know the amount of each fuels that a company can get from tank of crude oil. To know the production and productivity rate within six (6) months and also the month with the highest productivity and the factors that affect productivity rate.

2. BRIEF REVIEW ON FRACTIONAL DISTILLATION

On commercial scale, these gases are produced from the separation of air. The operation of air separation units (ASU) can be broadly classified into two categories, namely, non-cryogenic and cryogenic air separation processes. Non-cryogenic techniques for air separation include pressure swing adsorption (PSA) and membrane-based systems. These processes are relatively simple in operation; however, their major drawbacks are scalability and relatively lower quality of product gases [1-3]. Cryogenic processes, though complex in nature, are more efficient and cost-effective. They are widely applied on industrial scale for production of high-purity oxygen and nitrogen gases from air [1,2,6]. Many alternative designs of the cryogenic air separation process have been reported in literature. These include process designs based on 1, 2, and 3 distillation columns. The one-column process is the simplest design to produce high-purity oxygen and nitrogen from air. However, it offers somewhat limited opportunities for heat integration in the process and is rarely used in industrial practice [4]. The three-column air separation process is a relatively complex design and usually employed only when in addition to high-purity oxygen and nitrogen, separation of argon is also required [8].

2.1 Further Information of Crude Oil

Crude oil is the remains of an ancient biomass consisting mainly of plankton that was buried in mud and subjected to heat and pressure. It slowly ends up as a yellow to brown liquid which may form pools or be absorbed into porous rocks like shale [3]. Crude oil is an important raw material and the source of many utility

Table 1: Crude Oil Components Considering Specific Temperature [9]

Name of Component	State of Matter	Number of Carbons	Boiling Range	Uses
Residuals	Solid	Multiple ringed compounds with 70 or more carbon atoms	Greater than 600 degree Celsius	Coke, Waxes, tar for making other products
Fuel Oil	Liquid	Long Chain 20-70 Carbon atoms	Within the range of 370 to 600 degree Celsius	Useful as industrial fuel
Lubricating Oil	Liquid	Long Chain 20-50 Carbon atoms	Within the range of 300 to 700 degree Celsius	Motor oil, grease and other lubricants
Diesel Distillate	Liquid	Alkalines containing 12 or more carbons	Within the range of 250 to 300 degree Celsius	Heating oil and diesel fuel
Kerosene	Liquid	Mix of Alkanes and Aromatics	Within the range of 175 to 325 degree Celsius	Fuels for jet engines and tractors
Gasoline	Liquid	Mix of Alkanes and Cyclo-Alkanes	Within the range of 40 to 205 degree Celsius	Motor Fuel
Naphtha	Gas	Mix of 5-9 Carbon atom alkanes	Within the range of 60 to 100 degree Celsius	Can be further processed to make gasoline
Petroleum gas	Gas	Small Alkanes-usually 1-4 carbon atoms	40 degree Celsius	Heating, cooking and making plastics

Substances such as fuels and chemical feed stock from which endless products, including plastics and rugs are eventually manufactured [5]. It also consists of hydrocarbons of various molecular weights and other organic compounds crude oil is recovered mostly through oil drillings [9]. This comes after their studies of structural geology. Crude oil in one form or another, has been used since ancient times and is now important across society include in economy politics and technology. Today about 90 percent of vehicular fuel needs are met by oil. Table 1 below shows crude oil components considering specific temperature.

3. MATERIALS AND METHODS

3.1 Crude oil Process distillation

Several steps are taken to achieve fractional distillation process. Crude oil atmospheric distillation (Topping) is a process carried out in different phases, such as: Feed preheating – They include: (i) heating the mixture of the substances of crude oil (liquids) with different boiling points to a high temperature. The heating process is usually done with high pressure steam to temperatures of about 600 degrees Celsius. (ii) After the heating process, the mixture boils The mixture boils, forming vapor (gases); most substances go into the vapor phase. 3. The vapor enters the bottom of a long column (fractional distillation column) that is filled with trays or plates.

It is the operation of increasing the crude temperature passing it through tube/shell heat exchangers (usually floating heat type) where the heat Contained in hot products and pump rounds is recovered. **Desalting –** It is the operation of removing from crude salts, water and other impurities. It is carried out in a large vessel (desalter) where the salty water separation is facilitated by an electric field. **Preflashing –** It is the operation used to separate light fractions. (gas, LPG and light gasoline) at relatively low temperature in order to save energy (fuels) in the main heater. **Heating –** The operation is carried out in coils heaters (furnaces) where energy is supplied by the combustion of fuels such as fuel gas and/or fuel oil. The heat added to crude oil must be adequate to vaporize all products lighter than bottoms and produce refluxes. **Fractionation –** It is the operation of separating the different oil fractions. It is carried out in a distillation column (fractionators) where the different fractions are condensed at different temperatures. **Stripping –** It is the operation of removing light ends from products by injecting stripping steam. It is carried out in side columns (strippers) and in the main column bottom. **Stabilizing –** It is the operation of separating LPG from naphtha and is carried out in a distillation column (stabilizer). **Splitting –** It is the operation of separating light naphtha from heavy naphtha and is carried out in a distillation column (splitter).

3.2 Related Mathematical Formulas

The book written by Sharma (2007) has opened up helpful mathematical equations to help address the issue of productivity in terms of distillation and production of useful fuel. Thus, in this context, productivity is defined as the comparison between the quality of goods or services produced and the quality of resources employed in turning out these goods or services. Higher productivity means producing more with the given input resources of producing a given quality with lesser input resources productivity basically measures operating efficiency production and productivity are two entirely different terms from each other and this is that production is an absolute concept, productivity is a relative concept.

They are two types of productivity: Partial productivity and total productivity In restricted productivity, we consider the effect of only one input resource at a time. We have.

1. $\text{Labour productivity} = \dfrac{\text{Value of Total Output}}{\text{Value of Total Man-Hours Worked}}$

2. $\text{Machine productivity} = \dfrac{\text{Value of Total Output}}{\text{Value of Total Machine Hour Worked}}$

3. $\text{Material productivity} = \dfrac{\text{Value of Total Output}}{\text{Value of Total Material Input}}$

4. $\text{Energy Productivity} = \dfrac{\text{Value of Total Output}}{\text{Value of total man-hours worked}}$

3.3 Principle of Operation

In crude distillation towers, heat cannot be added to crude oil fractionators via a reboiler at the bottom. In order for a crude oil reboiler to work at or near atmospheric pressure, the outlet temperature would have to exceed 425c. At this temperature, most crude residues would simply crack to produce gas and coke. For this reason, all heat is added to the coke lower by preheating the feed. This technique results in a more practical heater outlet temperature of 350-370c. The heat added to the feed must be adequate to vaporize all the column products lighter than the bottoms. In addition, a small amount of vapor (3-4 volume o of crude) must be produced to generate reflux (over flash) for the fractionating trays between the feed inlet (and flash) zone and the lowest product draw tray. Heat is normally added to the crude oil feed in two distinct steps. First, it is transferred in shell and tube exchangers from the hot product streams used to generate reflux. Second, the final quantity of required heat is added in a direct fired furnace. Since all products are withdrawn from the crude tower at a temperature well above their storage temperatures, considerable heat is available for exchange between the crude and the products. Because the vapor liquid feed enters the column at high temperature, and the products are withdrawn at lower temperatures, a substantial amount of heat must be removed. This heat, called “reflux” heat, can be removed by an air cooled or water-cooled overhead condenser as is done with many other types of columns however such a system has two distinct disadvantages when used on a crude tower. First the internal vapor and liquid loading become very large at the top, requiring an oversized tower. Second, all the heat is rejected to the atmosphere where it has absolutely no value. A better approach to “reflux” heat removal is to withdraw hot liquid from one or more points in the column, cool it by heat exchange with incoming crude oil, and pump it back into the column (as seen in the figure below). The results are a lessening of overhead condensed duty, a reduction in upper lower loading, and at least the partial recovery of valuable heat. The disadvantage of a pump around is that its use reduces the volume of liquid flowing down the tower at all points above it. As a consequence, the separation between adjacent products is not as sharp as it would be with all heat removed from the overhead. Usually, this reduced fractionating capability 1s an acceptable price to pay for the benefits afforded by the pump around.

3.**4. Information presented**

Crude oil distillation (topping) is a physical operation used to separate the components of a mixture on the bases of their different boiling points, it is a process carried out in different phases such as: feed preheating, desalting, pre-flashing, heating, fractionation, stripping, stabilizing and splitting all this put together are the different phases in crude oil atmospheric distillation (topping). Taking my case study from Warri refinery using an atmospheric column as my example which is the column 10-col in Warri refinery I will give a simplified flow description in terms of fuels production in unit 10 topping Warri refinery.

The crude oil coming from Io-p-ol A/B pump, located put of unit battery limits, flows to (first preheating system) Io-E-or A/B, lo-E-02 and 10-1E-04 A/B.

Then the crude flows to 10-D-01 desalter from desalter, by means of 10-E-03, A/B, then the crude is splited into two streams flowing to 10-E-17/A/B and 10-E-18 AVB. After reunion, the crude flows to the 10-E-06 A/B, 10-E-07 AA/BIC, 10-E-05 and 10-E-21 (second preheating train). After preheating, the crude enters the 10-H-02. Heater the crude charge from the furnace partly liquid and partly vaporized is introduced into the preflash column T0-C-0/. The overhead vapours are condensed in the preflash OVHD condenser 10-A-10 and collected in the preflash OVHD receiver 10-D-14. The condensed water, collected in 10-D-14 bottom, is sent to the HC/sour water settlen, 10-D-17. The OVHD products, collected in 10-D-14, are charged by 10-p-27A/B pump to stabilize section. Some OVHD products through the pump 10-p-27AB, is returned to the preflash column as reflux. The gas from 10-D-14 is sucked by the off gas compression 10-k-01 together with gas from 10-D-04 after flowing through the demister in the k.0 drum 10-D-15.After compression in the compression, the gas is sent to the compression discharge drum 10-D-16. The liquid from 10-D-16, is sent to 10-C-05. The condensed water collected into 10-D-16 bottom is sent to 10-D-17. The heat balance of the column 10-C-07 is achieved by of pumparound which is taken by pump 10-p-26A/B after heat exchange in 10-B-15part of the liquid is sent to the main column 10-C-01. The water from 10-C-07(tray 22) is drawn off and it flows to the preflash column water separator 10-D-13, from 10-D-13 the water flows, to 10-D-17 and then it is pumped by 10-P-15 A/B to sour water stripper. From the He/sour water sttlen 10-D-17, the hydrocarbons are sent to 10-1)-03 atmospheric columns, OVHD receiver. The gasoline from 10-1D-14 is sent to stabilizer preheater exchange train, 10E-09 and 10-E-11, by 10-P-27 A/B pump.

Before entering the 10-C-05 the gasoline is mixed with the HIP separation liquid vapours are condensed in 10-A-05 and 10-E-25 and then collected in 10-D-04 bottom flows to the sour water stripper unit. LPG from 10-D-04 is sucked by 10-P-18A/B pump and sent to the gas plant. Some condensed bottom flows through 10-E-10, 10-E-16 and then with the light naptha from 10-p-16A/B, to storage. The heat required 1or 10--05 column is supplied by LGO in the stabilizer reboiler exchanger 10-E-12. Preflash column bottom is sucked by the pump 10-P-02A/B and sent through the 10-E-08A/B and 10-F-22. The intermediate P.A is taken from tray 32 and returned to the column above tray 34 by pump 10-p-09 after heat exchange with the cruden in 10-E-18/10-F-17 and 10-E-03, and after receiving the liquid draw from 10-p-26A/B. The bottom P.A 1S taken from tray 24 and recycled to the column above tray 25 by pump 10-p-08A/B after heat exchange with the crude in 10-E-21. The three side cuts are drawn respectively from the 35th, 26", and 11 trays and processed separately in the strippers 10-C-04, 10-C-03, and 10-C-02. The kerosene cut is fed into the stripper 10-C-04 above the 5 tray and vapours return to 10-C-01 above the 36" tray, while the stripped kerosene is sucked from 10-C-04 bottom by pump 10-p-06A/B and, after cooling in 10-A-03, is sent to storage. The LGO cut is fed into the strippers 10-C-03 above the stray and vapours return 10-C-01 column above the 27 tray while the stripped LGO is pumped by 10-p-05A/B 1s split into two streams to 10-E-12 and 10-E-13 respectively.

After reunion, the LGO flows the 10-E-02 and thereafter cooling in 10-A-4/10-A-07 coolers and 10-E-23 trim cooler, to storage. The HGO cut is fed into the stripper 10-C-02 above the 5^{th} tray and vapours returns to 10-C-0l column above the 12 tray while the stripped HGO is sent by 10-p-04A/B pump to 10-E-05 and 10-E-11 and finally after cooling 10-A-09 is sent to storage. ATM column bottom is sucked by the pump 10-P-03A/B and sent directly to vacuum unit. Alternatively it is sent to exchange train (10-E-08, 10-E-04 exchangers) and then to storage after cooling in 15-E-01 A/B and 15-E-02A/B. The water from 10-D-03 is sent to splitter preheater exchange train by 10-P-07 A/B pump. The gasoline flows to 10-E-14, 10-E-15 and 10 E-10 and then enters the splitter column 10-C-06 overhead splitter vapours are condensed in 10-A-06, splitter condenser and collected in 10-D-05, splitter accumulator. Light gasoline from 10-D-05 accumulation is pumped to storage by 10-P-16A/B pump. Some light gasoline product, through pump 10-P-16A/B is returned as reflux to the splitter column, gasoline from 10-C-06 bottom by 10-P-17A/b pump, is sent to the heavy 10-E-14 and 10-E-09 and then, after cooling in 10-A-08, flows to storage. The heat required for 10-C-06 column is supplied by LGO in 10-E-B splitter reboiler exchanger. The characters of the products in the above flow in the topping unit is summarize in Tables 2 - 9 below obtained from WRPC.

Table: 2: Properties of LPG as Investigated in BBPC Refinery Warri

Properties	Units	Values
Vapour	Kg/59cm	5.8
Volatility	^{o}Ccvwf	41
Specific gravity at 15^{o}c copper stripper corrosion composition	Kg/l	Ww
C^2	%vol	0.5
C^3	%vol	28
C^4	%vol	69
C^5	%vol	2.5

Table 3: Straight run light Naptha

Properties	Units	Values
TBP Cut	^{0}C	C5-90
Specific gravity at 15^{0}C	Kg/l	0.711
R.V.P	Kg/sqcm	0.7
R.O.N		75.8
Total Sulpur	%wt	0.0026

Table 4: Straight run light Naphta

Properties	Units	Values
TBP Cut	^{0}C	90-170
Specific gravity at 15^{0}C	Kg/l	0.781
R.V.P	Kg/sqcm	0.5
R.O.N		60.7
Total Sulpur	%wt	0.0123

Table 5: Kerosene

Properties	Units	Values
TBP Cut	^0C	170-250
Specific gravity at 15^{0}C	Kg/l	0.822
Flash point	^0C	47
Freezing point	^0C	-48
Smoke point	Mcm	21
Total Sulphur	%Wt	0.0419

Table 6: Light Gas oil

Properties	Units	Values
TBP Cut	^0C	250-350
Specific gravity at 15^{0}C	Kg/l	0.871
Flash point	^0C	66
Diesel index		-47
Cloud point	^0C	-15
Viscosity at 50^{0}C	Cst	2.02
Total Sulphur	%Wt	0.1528

Table 7: Heavy Gas Oil

Properties	Units	Values
TBP Cut	^0C	350-425
Specific gravity at 15^{0}C	Kg/l	0.906
Flash point	^0C	88
Pour point	^0C	19
Viscosity at 50^{0}C	Cst	12.82
Total Sulphur	%Wt	0.2627

Table 8: Residue

Properties	Units	Values
TBP Cut	^0C	› 425
Specific gravity at 15^{0}C	Kg/l	0.94494
Flash point	^0C	150
Pour point	^0C	39
Viscosity at 50^{0}C	Cst	182
Total Sulphur	%Wt	0.3561

3.5. Process Adopted

After the fuels have been processed from the topping unit then some of the fuels are further processed like the heavy naptha from the topping unit is further processed because the Octane number is not high enough for the Octane number to De high it is passed through a catalyst that is undergoing chemical change in the naptha Hydro treating unit and catalytic reforming unit. This catalyst is used to rearrange the chain in the heavy naptha and is non reversible after undergoing this process it comes out as a reformate (fuel). Furthermore heavy atmospheric gas oil is mixed with light vacuum gas oil and heavy vacuum gas oil and mixed together in the fluid catalytic cracking unit thus it produces liquefied petroleum gas, propylene and fluid catalytic cracking gasoline (fuel).

These (fluid catalytic gasoline (fuel), reformate (fuel) and light naphtha and sometimes liquefied petroleum gas depending on the octane number at which the products comes out within the topping unit) are all mixed in certain ratio to produce various useful derivatives (PMS, diesel, asphalt, etc.).

Note. The mixture must result up to an octane number of 90.

4. DATA ANALYSIS

In other to calculate for the productivity of fuels of this 10-C-01 column we first of all calculated the production rate. Since the fuels in excravos crude are tabulated below in percentage we first of all divide the percentage by hundred (100) and multiply by the amount of crude oil in the storage tank.

Table 9: Percentage of fuels in Excravos crude oil

Fuels	Percentage %
LPG (stabilizer OVHD)	2.0
Straight run light naptha	8.0
Straight run heavy naptha	16.0
Kerosene	15.0
Light gas oil	25.0
Heavy gas oil	4.0
Residue	30.0
Production calculation	Source (WRPC)

Amount of crude oil in the storage tank. =2,000,000 litres.

For liquefied petroleum gas 2,000,000 x 2.0 /100= 40,000 litres

For straight run light Naptha 2000,000 x 8.0/100 =160,000 litres.

For straight run heavy Naptha 2.000,000 x 16.0/100 = 320,000 litres

For kerosene 2,000,000 x 15.0/100=300,000 litres

For light gas oil 2,000,000 x 25.0/1000=500,000 1itres

For heavy gas oil 2,000,000 x 4.0 /1000 = 80,000 litres

For residue 2,000,000 x 30.0/1000= 600,000 litres

4.1 Productivity Calculation

Productivity general formula = Value of goods or services produced/Value of input resources

4.2 Total Production

Using a six (6) months interval for total productivity calculation which is from March to August.The storage tank contains 2,000,000 litres of crude oil Recall 159 litres = 1 barrel 2,000,000 litres = 2,000,000/159 = 12,579 barrels

A barrel of crude is = $37.22

Output = Number of barrel x price per barrel = 12,579 x 37.22 = $468,190

Input = Time = 1month = 31 days

:. Productivity = 468,190/32 = $15,103

Total Productivity in April

Output = 12,579 x 44.08

Input= 1 month = 30days

Productivity = 554,482 / 30 =$18,482

Total Productivity in May

Output =12,579 x 48.05 = $604,421

Input = 1month = 31 days

Productivity = 604,421/31= $19,497

Total productivity for June - Output = 12,579 x 50.09 =$630,082 = Input = 1month = 30days

Productivity = 630,082/30 = $21,003

Total productivity for July

Output = 12,579 x 49.05=$617,000

Input = 1month = 31 days

Productivity = 617,000/31=$19,903

Total productivity for August Output =12,579 x 46,000 = $578,634

Input = 1month = 31days - Productivity = 578,634/31= $I8,666

Partial productivity calculation for March

A barrel of crude is = $37.22 = 12,579 x 37.22 = $468,190

For machine productivity 24 hours M.P = 468,190 = 19,508

For 36 hours M.P = 468,190/36=13,005

Labour productivity for 8 hours - L.P = 468,190/8 = $58,524

Machine productivity for 24 hours M.P = 554,482/24= $23,103

4.3 Summary of Results

Table 10: Crude oil prices for six month

Months	Prices (USSD/Barrel) $
March	37.22
April	44.08
May	48.05
June	50.09
July	49.05
August	46.00

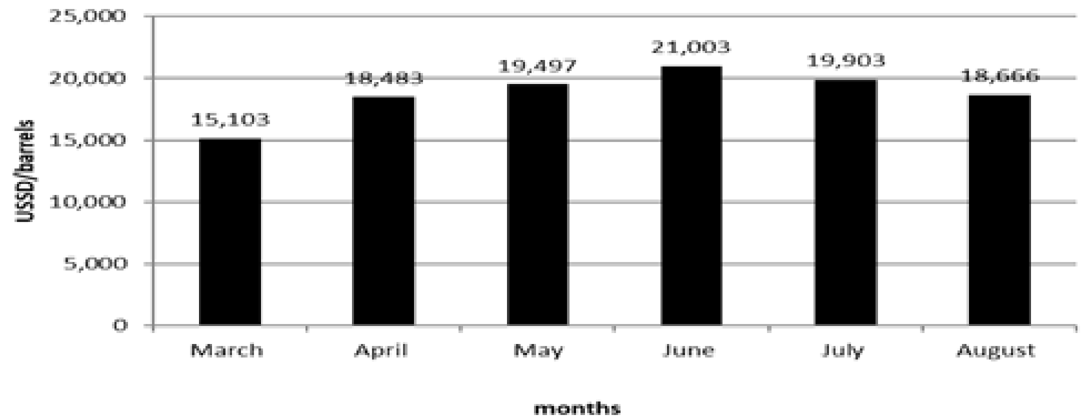

Figure 1: Crude oil Prices

Table 11: Crude oil Productivity in Six Month

Months	Productivity $
March	15,103
April	18,483
May	19,497
June	21,003
July	19,903
August	18,666

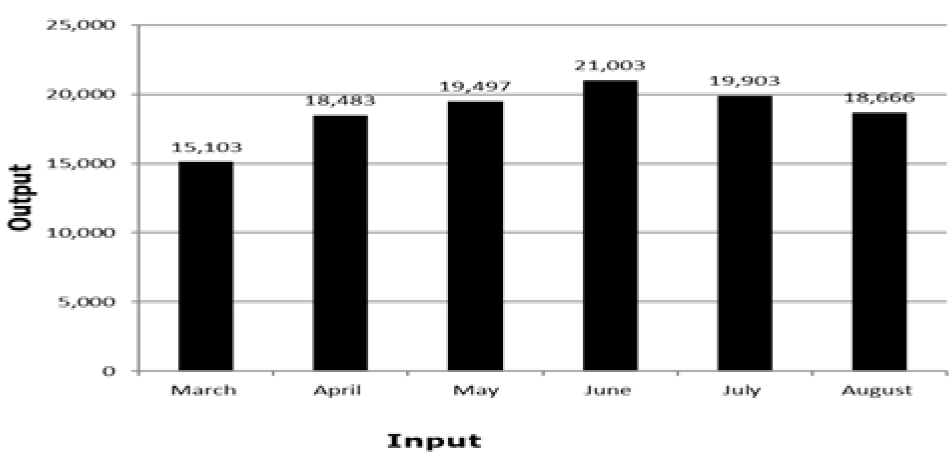

Figure 2: Total Productivity in Six Months

5. DISCUSSION

In Warri Refinery and petrochemical company the type of crude oil utilized is called Escravos crude. In refining escravos crude, using Warri Refinery as a case study, different processes are involved, some of these processes are: preflashing, desalting, heating, and fractionation, stabilizing and splitting. The products obtained from the fractional distillation tower in WRPC are liquefied petroleum gas (LPG), light naptha, heavy napthna, kerosene, light gas oil, heavy gas oil and residue. Production of fuels in a distillation tower is a continuous process that Can be upto six (6) months without been shutdown. Within this six (6) months productivity can be calculated to give the company an overview of it's profit and lose should they be any, from the above result productivity was at it's peak in the month of June been that the price of crude for that month was the highest. The lowest productivity month was in March where productivity was made at $15,103 from 12,579 barrels. These the shows that the prices of crude oil affects the production rate and productivity of crude oil in the company, As such for every 2,000,000 litres of crude oil in a tank the production rate of fuels are 40,000 litres for liquefied petroleum gas, 160,000 litres of light naptha, 320,000 of heavy naptha, 300,000 litres of kerosene, 500,000 litres of light gas oil, 80,000 litres of heavy gas oil and 600,000 litres of residue.

6. CONCLUSION

From the research machine and labour productivity was calculated and the production rate of the fuels in a 2,000.000 litres crude oil was also calculated. The fractional distillation column was studied and how the fuels are produced was extensively explained and I experienced one of the columns working that is column 10-c-01. The company should try and make information easily available for students research work and grant them access to the equipments in order to improve their knowledge in their work of study relating relevant information to the fractional distillation tower. It was observed that productivity was at it's peak in June while in March productivity was the lowest. In excravos crude the percentage of products that can be extracted from it are liquefied petroleum gas (2%), straight run light naptha (8o), straight run heavy naptha (16%) kerosene (15%), light gas oil 25%), Heavy gas oil (4%) and residue (30%). These products are produced in the above percentage. Light naptha, 320,000 of heavy naptha, 300,000 litres of kerosene, 500,000 itresot light gas oil, 80,000 litres of heavy gas oil and 600,000 litres of residue.

REFERENCES

1. Thorogood, R.M. Developments in air separation. Gas Sep. Purif. 1991, 5, 83–94.
2. Castle, W.F. Air separation and liquefaction: Recent developments and prospects for the beginning of the new millennium. Int. J. Refrig. 2002, 25, 158–172.]
3. Fu, Q.; Zhu, L.; Chen, X. Complete Equation-Oriented Approach for Process Analysis and Optimization of a Cryogenic Air Separation Unit. Ind. Eng. Chem. Res. 2015, 54, 12096–12107. [CrossRef]
4. Smith, A.R.; Klosek, J. A review of air separation technologies and their integration with energy conversion processes. Fuel Process. Technol. 2001, 70, 115–134.
5. Zheng, J.; Ye, H.; Li, Y.; Yang, Y.; Si, B. A Parametric Sensitivity Study and Comparison Analysis on Multiple Air Separation Processes. Ind. Eng. Chem. Res. 2019, 58, 9087–9098.
6. Haider, P.; Freko, P.; Lochner, S.; Reiter, T.; Rehfeldt, S.; Klein, H. Design of a test rig for the simulation of startup procedures in main heat exchangers of air separation plants. Chem. Eng. Res. Des. 2019, 147, 90–97.
7. Timmerhaus, K.D. Cryogenic Process Engineering. In Encyclopedia of Physical Science and Technology, 3rd ed.; Meyers, R.A., Ed.; Academic Press: New York, NY, USA, 2003; pp. 13–36. ISBN 978-0-12-227410-7.
8. Zhu, Y.; Liu, X.; Zhou, Z. Optimization of cryogenic air separation distillation columns. In Proceedings of the World Congress on Intelligent Control and Automation (WCICA), Dalian, China, 21–23 June 2006; Volume 2, pp. 7702–7705.
9. M.O.Okwu and Nwachukwu Angella (2018) A review of Fuzzy Logic Applications in Petroleum Exploration, Production and Distribution Operations. *Journal of Petroleum Exploration and Production Technology. Springer.*